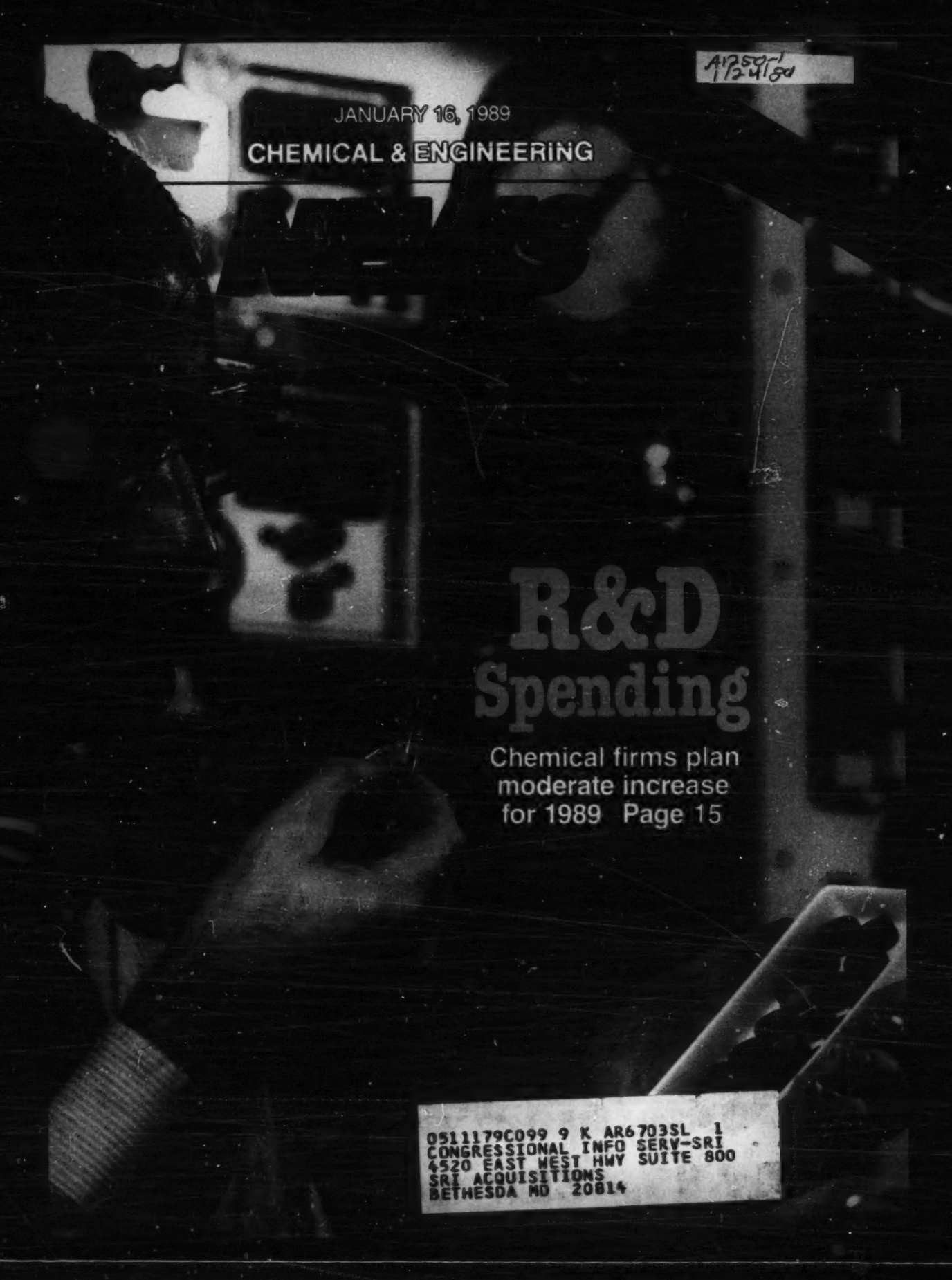
A1250-1
1/24/89

JANUARY 16, 1989
CHEMICAL & ENGINEERING

NEWS



R&D Spending

Chemical firms plan moderate increase for 1989 Page 15

0511179C099 9 K AR6703SL 1
CONGRESSIONAL INFO SERV-SRI
4520 EAST WEST HWY SUITE 800
SRI ACQUISITIONS
BETHESDA MD 20814

CHEMICAL & ENGINEERING
NEWS

Volume 67, Number 3
CENEAR 67 (3) 1–84
ISSN 0009-2347

JANUARY 16, 1989

News of the Week

■ **In his final budget, submitted to Congress last week, President Reagan proposes 7% rise in federal R&D spending for fiscal 1990.** **Page 6**

■ **Chemical arms concerns were focus of meeting in Paris attended by nearly 150 nations.** **Page 7**

■ **European chemical production will slow in 1989, say British and European industry groups.** **Page 7**

■ **Study by American Association for Clinical Chemistry shows that labs can achieve nearly 100% accuracy in testing for illegal drugs in urine.** **Page 8**

Cover: W. R. Grace scientist examines superconductor samples at Washington Research Center in Columbia, Md.

Letters 4
Editor's Page 5

Concentrates
Business 13
Government 21
Science/Technology 30

The Departments
Books 44
ACS Comment 50
People 53
New Products 58
Newscripts 84

Business

Changing markets and innovations are providing new growth opportunities for industrial gases, according to a recent study; a Union Carbide-led team helped erect shelters made of plastic film and steel piping in the earthquake-ravaged city of Spitak, Armenia. **Page 19**

Government

Study aimed at helping new Administration tackle environmental problems claims market-oriented approach is more effective, less costly; plethora of advice for Bush on a range of issues is rolling in from the scientific and technical community. **Page 22**

Science

Structure of protein encoded by mutant human oncogene is determined by chemists at the University of California, Berkeley. **Page 31**

Education

Management-of-technology M.S. program launched via satellite broadcasting. **Page 34**

Technology

Benchtop atomic-emission detector for gas chromatography introduced by Hewlett-Packard; NRC panel spotlights problem areas in shuttle booster redesign. **Page 37**

Meetings

Preliminary program for ACS national meeting in Dallas lists symposia, includes advance registration form. **Page 55**

Cover Story

Major U.S. chemical producers plan a moderate 9% increase in R&D spending in 1989, according to a survey by C&EN. **Page 15**

Chemical & Engineering News

1155—16th St., N.W., Washington, D.C. 20036

Editor: Michael Heylin
Assistant Managing Editors: David M. Kiefer, James H. Krieger, Janice R. Long, Donald J. Soisson, William J. Storck. **News Editor:** Wilbert C. Lepkowski
Staff Editor: Ernest L. Carpenter
Senior Editors: New York: Earl V. Anderson, Stephen C. Stinson; Chicago: Joseph Haggin; Washington: Doron Dagani, Lois R. Ember, Bette Hileman, Rebecca L. Rawls, Pamela S. Zurer
Associate Editors: Stuart A. Borman, Mairin B. Brennan, Richard J. Seltzer
Service Departments Editor: Dolores Miner
Editing Services: Anne Riesberg (Head), Arlene Goldberg-Gist (Editorial Assistant), Patricia Oates (Administrative Assistant)
News Bureaus: Northeast News Bureau: (201) 906-8300 Marc S. Reisch (Associate Editor), Ann M. Thayer (Assistant Editor), Rachel Eskenazi (Administrative Assistant). Chicago: (312) 256-4143 Ward Worthy (Head). Houston: (713) 973-8161 Bruce F. Greek (Head). Washington: (202) 872-4495 David J. Hanson (Head). West Coast: (415) 653-3630 Rudy M. Baum (Head). **Foreign Bureau:** London: (01) 540-0414 Dermot A. O'Sullivan (Head), Patricia L. Layman (Associate Editor)
Graphics and Production: Leroy Corcoran (Manager). Alan Kahan (Art Director). Barbara Fryer (Production/Art Director). Linda Mattingly (Staff Artist). Diane Kelly (Costing).
Business Manager: Arthur Poulos
Circulation Development: Claud K. Robinson

ADVISORY BOARD: Jacqueline K. Barton, Ernest H. Drew, Harry G. Drickamer, A. Nicholas Filippello, Adam Heller, Koji Nakanishi, Robert M. Simon, William P. Slichter

Published by
AMERICAN CHEMICAL SOCIETY
(202) 872-4600; TDD (202) 872-8733
John K Crum, Executive Director

PUBLISHING BOARD: Jean'ne M. Shreeve (*Chairman*); *Board of Directors Chairman:* Ernest L. Eliel; *President:* Clayton F. Callis; and four members of the Society Committee on Publications yet to be appointed

© Copyright 1989, American Chemical Society

Subscription & Member Record Service: Send all new and renewal subscriptions with payments to: Controller, ACS, P.O. Box 28597, Central Station, Washington, D.C. 20005. Correspondence and telephone calls for changes of address, claims for missing issues, subscription service, status of records and accounts should be directed to: Manager, Member & Subscriber Services, ACS, P.O. Box 3337, Columbus, Ohio 43210; (800) 333-9511 or (614) 447-3776.

For changes of address, include both old and new addresses with ZIP code numbers and mailing label from a recent issue. Allow four weeks for change to become effective. Claims for missing numbers will not be allowed if loss was due to failure of notice of change of address to be received in the time specified; if claim is dated (a) North America: more than 90 days beyond issue date, (b) all other foreign: more than one year beyond issue date; or if the reason given is "missing from files."

Subscription Rates 1989. Printed editions: nonmembers U.S. 1 yr. $55, 2 yr. $99, outside U.S. 1 yr. $86, 2 yr. $161. Air freight rates available on request. Rates above do not apply to nonmember subscribers in Japan, who must enter subscription orders with Maruzen Co. Ltd., 3-10 Nihonbashi 2-chome, Chuo-ku, Tokyo 103, Japan. Tel: (03) 272-7211. Single copies: Current $7.00. Rates for back issues and volumes are available from Microforms & Back Issues Office, ACS, 1155—16th St., N.W., Washington, D.C. 20036. Back and current issues available on microfilm and microfiche. Rates on request from Microform Program, ACS.

Chemical & Engineering News (ISSN 0009-2347) is published weekly except for the last week in December by the American Chemical Society at 1155—16th St., N.W., Washington, D.C. 20036. Second-class postage paid at Washington, D.C., and additional mailing offices. POSTMASTER: Send address changes to Chemical & Engineering News, Membership & Subscription Services, P.O. Box 3337, Columbus, Ohio 43210. ACS assumes no responsibility for the statements and opinions advanced by the contributors to its publications.

Advertising Management
CENTCOM LTD.
(For list of offices see page 83)

LETTERS

Combating chemophobia

SIR: Several years ago, a few miles from some of the greatest centers of chemical education in the country, the Bay Bridge between San Francisco and Oakland was closed for seven hours following the spillage of one 50-lb bag of talc.

The general reaction of the chemical industry to this kind of irrational chemophobia has been a chemophobic panic of its own—the elimination of "chemical" from corporate names, and of "chemistry" from descriptions of its activities.

Meanwhile, day in and day out, the business of chemicals has become fair game for sensation-mongering by the press and by television news. This week, a bylined story in the *San Francisco Chronicle* described industrial alcohol as "a deadly chemical." The expression "cancer causing," used ignorantly and irresponsibly, is heard almost daily on the news.

Editors and TV station managers are, in my experience, sensitive to factual criticism. We have them outnumbered, these keepers of the chemophobia flame. Let's jump on their stories, in writing, until they get their facts straight.

Tom Cleary
Mendocino, Calif.

Priestley Medal address

SIR: I hope I may be permitted some belated comments on Frank H. Westheimer's Priestley Medal address (C&EN, July 4, 1988, page 32) and the subsequent correspondence (C&EN, Aug. 22, 1988, page 3). Our copies of C&EN have been late in coming here [to Australia]. I believe David Wagger is right to state that science education must begin in the elementary grades; Westheimer discusses college education, but at this stage attitudes have already been formed and students have typed themselves as scientists or humanists. It is too late at college to try to change this. Juergen Braun makes the important point that current attitudes to science are a result of our cultural and social heritage. However, I do not think that any of the three commentators delves to the roots of the matter.

We have built up a distinction between science and the humanities that is purely an artificial distinction, derived from our cultural heritage as suggested by Braun. This division is of comparatively recent date, but perhaps having remoter links to medieval attitudes to learning. We do not need this separation of science from other learning, and other cultures do not seem to have introduced it. The success of Islamic science between 750 and 1100 AD was built on Quranic injunctions to acquire knowledge and on the absence of distinctions in value between aspects of that knowledge (for example, between science, technology, history, arts, and so forth). Why do we continue to cut learning in half?

It is better that we regard the world of learning as a continuum with the study of the natural world at one pole and the study of the works, thoughts, and aspirations of women and men at the other. Any real-world problem has scientific aspects mingled with human and social ones. An obvious example is the environmental debate around the use of pesticides in agriculture. No one can claim to be educated who cannot show some competence across this spectrum of learning. Science is not an entity separable from the generality of education.

The distinction currently given to science was brought to my attention clearly at my daughters' school, one which places a high priority on girls' getting equal opportunities with boys in math and science. The staff members were very apprehensive about introducing science into the primary school curriculum, afraid that it might be too early. My comment was that science is an integral part of education and begins at day one of school life. Once the education system identifies science as an alien and an add-on, then we have lost the battle. The defeat sustained by Westheimer at Harvard was an inevitable consequence of unrecorded battles lost in primary education.

Let us spread the notion of the universality of learning and rigorously reject all distinctions between branches. To educate, we must engender a curiosity in the natural and the human world, and teach the discipline of learning. There can be no distinction between scientist and nonscientist, or between humanist and nonhumanist. All educated persons are scientists and humanists.

Hugh D. Crone
Heidelberg, Australia

Breath of fresh air

SIR: Congratulations to my fellow chemists and chemical engineers! The letters by A. C. Nixon, Philip Sadtler, and David R. Fagerburg (C&EN, Nov. 21, 1988, page 2) are like a breath of fresh air after the dose of hysteria we have been receiving for years from the environmentalists.

Alfred N. Rogers
Pleasanton, Calif.

related activities is also up 14% to $1.8 billion, and funding for science and engineering education is up 11% to $190 million. Funding for the materials research division is up 18% to $135 million, for the chemistry division, 7% to $103 million, and for chemical and thermal systems engineering, 8% to $36 million. The NSF budget request allows for continued funding of the 11 science and technology centers announced last year, as well as initiation of a second competition for eight to 10 centers in fiscal 1990.

For the first time, this year's Special Analysis J of the R&D budget proposal breaks out the funding for programs that are supported by a number of agencies. It shows, for instance, that funding for the U.S. global change research program is slated to grow more than 40%, to $191 million, in fiscal 1990. Federal support for both low- and high-temperature superconductivity research is to increase 14% to $287 million. And support for technology transfer activities is to rise 5% to $510 million.

Janice Long

Chemical arms action urged at world meeting

A five-day conference on chemical weapons attended by nearly 150 nations ended last week in Paris with a vaguely worded communiqué condemning the use of chemical weapons, urging the swift completion of a stronger ban on such weapons, and reaffirming the powers of the United Nations Secretary-General to investigate charges of illicit use.

As one U.S. expert who asks not to be named says, it is a consensus document, and "the U.S. never expected precise language." The U.S. and its allies also never expected Soviet Foreign Minister Eduard A. Shevardnadze to announce that the U.S.S.R. would "immediately begin eliminating" its stock of chemical weapons, something the U.S. has already begun with its old, unitary weapons.

In his keynote address to the conference, Secretary of State George P. Shultz called on nations to renew their commitment to abide by "international norms relating to CW use." He also asked that nations that have not signed the 1925 Geneva Protocol do so. This protocol bans the use but not the production or possession of chemical arms. And Shultz urged that the UN Secretary-General's investigatory powers be "reinforced and enhanced."

Shultz: abide by international norms

The U.S. never explicitly stated what it meant by "enhanced" powers. And the final communiqué calls only for the "completion of the work undertaken to strengthen the efficiency of existing procedures." The Secretary-General has appointed a group of experts that is now developing suggestions to clarify and improve existing investigatory procedures.

During the conference, three countries—South Korea, North Korea, and Laos—signed the Geneva Protocol, bringing the number of signatory countries to 123. Others are expected to sign.

Though the final consensus document urges a speedy conclusion to ongoing talks in Geneva on a global, verifiable treaty banning the production, possession, and use of chemical weapons, the document fails to strongly address two other issues the U.S. raised. Shultz asked for measures to prevent the spread of chemical arms, especially to terrorist-supporting countries. Instead, the final document calls for countries to "exercise restraint and to act responsibly." The U.S. delegation also sought support for sanctions against countries using chemical arms in contravention of the 1925 protocol. Sanctions are addressed obliquely when the final document calls on the UN to take "appropriate and effective steps" under its charter.

Domestically, Sen. Don Nickles (R.-Okla.), who attended the conference with Shultz, says he will work for legislation imposing sanctions on U.S. and foreign firms contributing to chemical weapons proliferation. Last September Sen. Robert Dole (R.-Kan.) offered such a bill. Nickles says he will cosponsor a modified version of that bill, which Dole plans to reintroduce early this year.

The U.S. was not alone in not getting its way at the conference. A block of Arab delegates tried unsuccessfully to derail the conference by insisting that elimination of chemical arms be linked to the destruction of nuclear weapons. This was seen as a move against an alleged Israeli arsenal of nuclear weapons. Both the U.S. and U.S.S.R. objected to this move. After making the point in speech after speech, the Arabs dropped the ploy when it was agreed that the final document would call for "general and complete disarmament under effective international control."

Though it wasn't entirely successful, the U.S. was satisfied with the Paris exercise. As one close observer says, "80 foreign ministers [who attended the conference] are painfully aware of this issue now."

Lois Ember

European chemical growth to slow in 1989

Chemical production last year in Western Europe outstripped forecasts of early last year—in some cases, significantly so. That puts a special burden on forecasters trying to predict the performance of the industry this year.

Economists at the annual Business Outlook Conference of the

Chemical Industries Association in Britain last week were quick to point this out. Nonetheless, predict they did. The general consensus of U.K. economists is: Growth is slowing down, but is still good. This forecast agrees with the 1989 business outlook issued late last year by the European Council of Chemical Manufacturers Federations (CEFIC) in Brussels.

One of the keys to last year's performance, and to this year's continuation of that performance, is capacity constraints, says Richard Freeman, chief economist at ICI and chairman of the Chemical Industry Association's forecasting panel. "Fears of capacity constraints in 1988 seem to have been overstated," he adds. "This was the case not only in the U.K. but in other European countries as well."

The association's forecasting panel projects that production in 1989 is likely to be capacity-constrained "unless there is a marked slowdown in the rate of growth of demand," Freeman says. However, in making its predictions the panel assumes that supplies available in the U.K. will not be limited by capacity in the various chemical sectors. It also makes the assumption that average oil price will be $15 per barrel.

All told, the panel expects U.K. chemical production to grow 3% in 1989, following the 6 to 6.5% increase of 1988. Freeman terms the projected growth a "more sustainable level of increase." The panel also forecasts a 3.5% increase in chemical exports, down slightly from 5% in 1988, and a 4% rise in chemical imports, down from 7% in 1988.

British chemical growth to slow this year

Production, annual change	1989	1988
Plastics	13.0%	4.0%
Pharmaceuticals	8.0	4.5
Cosmetics, perfumes	6.5	2.5
Dyes	3.0	1.0
Organics	6.0	4.0
Inorganics	5.0	1.5
Paints	4.5	2.5
Detergents	3.0	2.0
Fibers	−4.0	0
Fertilizers	−8.0	0

Source: U.K. Chemical Industries Association

Chemical growth is also expected to slow down in the other Western European countries (C&EN, Dec. 12, 1988, page 34). For Western Europe as a whole, CEFIC projects a 3% rate of growth for chemical production, compared with just under 6% in 1988. "There is a strong consensus among European chemical industry forecasters about prospects for industrial production this year," Freeman says.

There is also a consensus that imports and exports will rise at a slower rate this year than in 1988 across Western Europe. CEFIC projects that chemical exports will increase 3% this year, compared with 6.5% last year. And it expects imports to grow only 2.5%, compared with 7% in 1988.

Costs for the U.K. chemical industry will rise in line with general inflation, the U.K. forecast panel assumes. It thus predicts that margins will be much the same as in 1988 or a little higher. "On this basis," says Freeman, "profits in the industry will show another healthy rise, but less so than the probably 10 to 15% in 1988."

The combination of strong demand and rising profits, he adds, is expected to bring another good year for investment in the U.K. industry: The U.K. group's survey of investment intentions indicates an increase of 8% in volume terms—a significant commitment, although a slight drop from the 12% rise in 1988.

Those predictions for the U.K. chemical industry track closely with the predictions of CEFIC for chemical industry investment throughout Western Europe. According to CEFIC, investment is expected to grow 6% this year, down from 9% in 1988. The relatively high level of investment in 1988, CEFIC notes in its economic outlook, was spent mainly on "extension and innovation," following the rationalization in previous years. This has resulted in higher productivity and improved processes and products throughout the industry.

Patricia Layman

Drug urinalysis can be very reliable

Labs can achieve nearly 100% accuracy in testing for illegal drugs in urine, a new study by the American Association for Clinical Chemistry (AACC) shows. "After today, inaccuracy should not be used as an argument against drug-testing programs," said toxicologist Christopher S. Frings last week as he released the results.

Thirty-one out of the estimated 150 commercial U.S. labs that carry out drug testing for employers participated in the study, according to Frings, who heads AACC's public issues committee. They were sent blind samples of urine containing cocaine, opiates, marijuana, amphetamines, or phencyclidine (PCP).

The labs correctly identified samples containing drugs 97% of the time, with no false positives. Various immunoassay methods were used for initial screenings, and samples that tested positive were further analyzed by gas chromatography-mass spectrometry.

"AACC will not suggest to you that all laboratories accepting employee drug-screening specimens are doing accurate work," Frings says. "But we maintain that laboratories that follow key operating procedures can demonstrate high accuracy in drug testing." AACC issued guidelines in 1987 to help employers choose and monitor a drug-testing lab (C&EN, August 3, 1987, page 26).

About 3% of private U.S. businesses have some sort of drug-testing program in place, according to a survey just released by the Department of Labor. But those companies employ about 20% of U.S. workers, as large companies are much more likely to have drug-testing programs than are small firms, the survey found.

However, such programs are being challenged regularly in the courts by labor unions and employee groups. Their lawyers argue that it is an invasion of privacy to force an employee to submit to a drug test without some reason to suspect he or she has used illegal drugs. Decisions will be rendered by June in two such cases now being considered by the U.S. Supreme Court.

Pamela Zurer

Chemical Industry R&D Spending To Increase Moderately

Ten major chemical producers plan 9% hike in research expenditures this year, translating to more than 7% in constant-dollar terms

Marc S. Reisch,
C&EN Northeast News Bureau

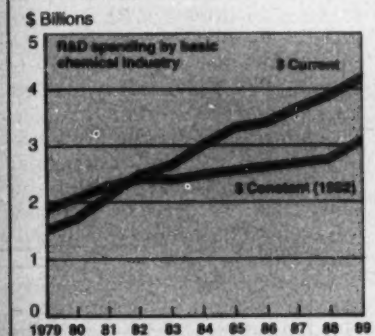
Major U.S. chemical and diversified companies plan a moderate increase in research and development spending in 1989, according to a preliminary survey by C&EN. The survey indicates that R&D spending for 10 companies that responded will rise 9% from last year. That is up from a 7% increase by the same 10 companies in 1988 compared with 1987.

The 9% increase found by C&EN's survey is in marked contrast to the 3.4% increase that Battelle Columbus Laboratories forecasts for all R&D spending (C&EN, Jan. 9, page 23). Battelle projects that total R&D spending in the U.S. will reach $129.2 billion in 1989. However, Battelle admits that industrial R&D spending, comprising about half of total R&D spending, will rise faster (4.5%) than government spending.

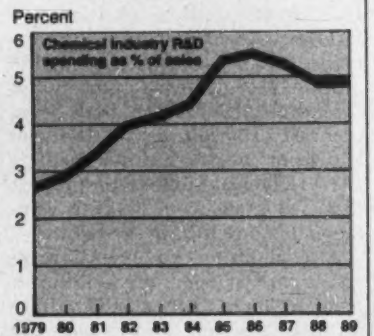
Part of the increased spending will be absorbed by inflation. Battelle forecasts a real increase in R&D expenditures of about 2%. Thus Battelle's forecast for 1989 R&D inflation is 1.4%. By contrast, last year Battelle predicted 1988 R&D inflation of about 4.5%. Factoring in Battelle's R&D-inflation forecast for 1989, the 10 chemical producers surveyed by C&EN will increase real R&D spending 7.6% in 1989.

C&EN's survey this year, as usual, does not include Du Pont. If that company's increase in R&D spending were to differ significantly from the 10 companies that responded to the survey, the final industry spending estimates could be drastically altered. In 1987, for instance, Du Pont spent $1.2 billion on R&D, excluding that for the former Conoco operations. In that year, its spending accounted for more than 33% of the total spent by the 12 chemical producers included in the survey.

R&D spending will rise modestly in 1989 . . .



. . . and will remain level as percent of company sales



Note: For companies listed on page 16. Sources: C&EN surveys and estimates, Battelle Columbus Laboratories

Also missing in this year's survey is Hercules. A company spokesman says that Hercules is altering its R&D accounting procedures so that its European operations report in their R&D figures coincident with U.S. R&D spending estimates.

A planned emphasis this year on certain growth categories revealed in a survey of R&D directors accounts in part for the good increase in 1989 R&D expenditures for the 10 chemical producers C&EN surveyed. The R&D directors survey was conducted by Flad Associates, a Madison, Wis.-based firm specializing in laboratory design and construction. The survey, released in September 1988, asked respondents to anticipate capital spending on physical plant and equipment dedicated to R&D. Results show that for the period 1987 to 1989, expenditures would grow fastest for R&D facilities for industrial organic and inorganic chemicals, miscellaneous chemical products, drugs and related products, and rubber and plastic products.

The survey, with sponsorship by the University of Wisconsin and with assistance from the National Science Foundation, the Industrial Research Institute, and *Research & Development* magazine, anticipates increased research emphasis on categories essential to the 10 chemical producers included in C&EN's survey.

Another factor accounting in part for a higher real increase in R&D spending for the 10 companies compared with the very modest level of increase for all industry that Battelle predicts is the outstanding sales and earnings profile of these 10 companies and indeed for the industry as a whole over the past year. C&EN's survey of 30 major chemical firms (C&EN, Nov. 14, 1988, page 24) showed that sales through the third

Eli Lilly and Arco will post biggest gains in R&D spending

$ Millions	Planned 1989	Actual 1988	Planned 1988	1987	1986	1985	1984	1983	Change from previous year 1989	Change from previous year 1988	R&D spending as % of sales 1988	R&D spending as % of sales 1987
CHEMICAL COMPANIES												
Air Products[a]	$ 72	$ 72	$ 67	$ 57	$ 61	$ 51	$ 44	$ 40	0%	26.3%	2.9%	2.7%
American Cyanamid	385	360	356	314	278	251	232	208	6.9	14.6	7.5	7.5
Dow Chemical	850	760	720	670	605	547	507	492	11.8	13.4	4.9	5.0
Du Pont[b]	na	na	na	1223	1156	1144	1097	966	na	na	na	6.9
Ethyl	58	58	52	50	47	47	40	39	0	16.0	2.9	2.9
W. R. Grace	132	118	120	107	94	92	81	73	11.9	10.3	2.3	2.4
Hercules	na	na	76	74	71	76	72	74	na	na	na	2.7
Monsanto	615	590	538	615	596	470	370	290	4.2	−4.1	6.7	8.1
Olin	65	56	60	62	56	53	52	49	16.1	−9.7	2.5	3.2
PPG Industries	250	225	250	227	204	176	150	127	11.1	−0.9	3.8	4.4
Rohm & Haas	185	163	150	142	133	124	109	100	13.5	14.8	6.4	6.4
Union Carbide	193	166	175	159	148	275	265	245	16.3	4.4	2.1	2.3
TOTAL	$2805	$2588	$2488	$3700	$3449	$3306	$3019	$2703			4.5%	5.3%
ANNUAL CHANGE[c]	9%	7%		7%	4%	10%	12%	8%				
DIVERSIFIED COMPANIES												
Allied-Signal[d]	600	600	670	400	360	298	258	245	0	50.0	4.7	3.6
Arco Chemical	44	37	na	26	30	29	29	na	18.9	42.3	1.6	1.3
Eli Lilly	600	500	500	466	427	370	341	294	20.0	7.3	11.9	12.8
FMC	na	na	134	132	146	149	121	102	na	na	na	4.2
Merck & Co.	na	650	na	566	480	426	393	353	na	14.8	11.2	11.2
Morton Thiokol[d,e]	52	45	43	40	38	34	28	21	15.6	12.5	2.0	2.0
SmithKline Beckman	na	500	na	424	377	310	279	265	na	17.9	10.0	9.8
TOTAL	$1296	$2332	$1347	$2054	$1858	$1616	$1449	$1283			7.2%	6.8%
ANNUAL CHANGE[c]	10%	21%		11%	15%	12%	11%	18%				

a For fiscal year ended Sept. 30. b All figures exclude Conoco. c For those companies reporting. d Includes all company-financed R&D, but excludes contract R&D. e Fiscal year ended June 30. na = not available.

quarter of 1988 were 18% ahead of the previous year's first nine months, and earnings for the group were ahead by 75%. Given that sensational performance, management can afford to shore up their companies' R&D effort.

This year's survey conservatively estimates that the average increase in sales was 15% for the 10 companies that reported 1988 R&D figures. As a result, R&D spending as a percentage of sales decreased to 4.5% in 1988 compared with 5.3% in 1987. Part of the reason may be that sales growth for the chemical industry was better in 1988 than had been anticipated when 1988 R&D spending plans were put into place. Based on spending plans of the 10 companies in the survey, 1989 R&D spending as a percentage of sales will probably remain about the same as in 1988.

The biggest increase in R&D spending for 1989 is planned by Union Carbide, whose spending is slated to rise 16.3% to $193 million. The 1989 estimate excludes Carbide's catalysts business, which was combined with Allied-Signal's UOP subsidiary in a joint venture formed in August 1988. The planned 1989 increase follows a 4.4% increase the year before.

The second largest R&D increase in 1989 is planned by Olin, which expects to increase R&D funding 16.1% to $65 million. That increase follows a decline of 9.7% the year before when Olin says it spent $56 million. A company spokesman says that the 1988 decline both from planned expenditures for the year and from the $62 million spent in 1987 reflect a number of projects that had gone from R&D to commercialization during the year.

Also planning a double-digit increase in 1989 spending is Rohm & Haas. It plans to spend $185 million on R&D this year, up 14% over last year's level. The increase follows a 15% increase in R&D spending in 1988, when the company figures it actually spent $163 million. Rohm & Haas spends a consistently high percentage of sales on R&D; in both 1988 and 1987 it spent 6.4% of sales on R&D.

Also planning to boost its R&D spending more than in 1988 is W. R. Grace, with a 12% increase this year to $132 million. Last year's increase was 10%. Grace says it actually spent $118 million in 1988 on R&D.

Dow Chemical also is planning a considerable boost in its 1989 R&D expenditures. The company predicts it will spend $850 million this year, a 12% increase over the $760 million it gives as its best estimate at this point for its R&D spending in 1988. That 1988 level of spending was itself a 13% increase over spending in 1987.

Also increasing its spending above the average for the 10 companies is PPG Industries, which estimates its 1989 R&D spending at $250 million, up 11% from 1988. Because the

company's actual 1988 R&D spending fell $25 million short of its planned $250 million expenditures for the year, its R&D spending in 1988 declined a marginal 0.9%.

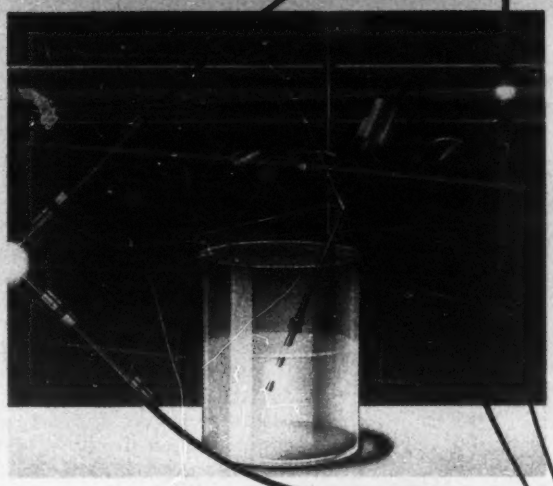
Only two of the 10 companies reported a spending increase lower than the 9% average increase for the group. American Cyanamid plans to increase expenditures 7% to an estimated $385 million. In 1988 it spent $360 million, up 15% from 1987. Despite the low rate of increase for 1989, Cyanamid's R&D spending as a percentage of sales, at 7.5% in both 1987 and 1988, has been consistently higher than for most other companies in the survey. No other company beat that figure in 1988 and only Monsanto reported a higher percentage, 8.1%, in 1987.

For its part, Monsanto predicts 1989 R&D expenditures that will keep its investment in the future at a rate slightly better than the rate of inflation. Monsanto says it will spend $615 million on R&D in 1989, only 4% ahead of 1988, when it spent $590 million. The lower 1988 R&D figure compared with 1987 pulled Monsanto's R&D spending as a percentage of sales down to 6.7%.

Ethyl and Air Products predicted no increase in their 1989 R&D spending. Ethyl, however, spent more in 1988 than it originally anticipated, pushing its R&D spending up 16%. Air Products says that 1989 spending will remain level with 1988 as the company refocuses its efforts following a 26% expansion in R&D expenditures in 1988.

Among diversified manufacturers, four companies responding to the survey—Allied-Signal, Arco Chemical, Eli Lilly, and Morton Thiokol—plan to increase their R&D budgets an average of 10% in 1989. Their figures include internally generated R&D contracts only and not government contracts.

As in last year's survey (C&EN, Jan. 18, 1988, page 9), the only pharmaceutical manufacturer that could provide an estimate of its 1989 spending was Eli Lilly. The company estimates that it will spend about $600 million in 1989, up 20% over the previous year and higher than the 7% increase in 1988 over 1987 R&D expenditures. Merck and



In Situ UV-VIS-NIR Analysis without being there.

Remote Spectroscopy. A new twist on a familiar theme. Many of the world's leading corporations are already utilizing the advantages of Fiber Optics for:

LABORATORY RESEARCH, PILOT PLANT EVALUATION, AND IN-LINE PROCESS MONITORING.

Guided Wave pioneered the use of fiber optics for remote in-situ spectroscopy. Today, we have solidified our leadership.

We provide all of the tools necessary for proper implementation of this progressive technology:

Scanning Spectrophotometers, Fiber, single strand and bundles, Probes for most applications, Advanced calibration and monitoring software, Optical Multiplexers and, of course, application expertise.

Solving problems, that's our business. Our approach for in-situ analysis is sometimes the only way to handle a tough measurement problem — without being there.

We have sales and service people worldwide to discuss your analytical needs. So, if you have a tough measurement problem, call the LEADER in Remote Spectroscopy. . . GUIDED WAVE.

GUIDED WAVE

Guided Wave, Inc. (Headquarters), 5190 Golden Foothill Parkway, El Dorado Hills, CA 95630, Tel. (916)355-8110.
Guided Wave International AB, Karbingatan 22, S-252 66 Helsingborg, Sweden, Phone Int. +46 42 20 10 25.
Abteilung von Tecator GmbH, Ludwigstrasse 24-26, D-6054 Rodgau 1, BRD, Phone Int. +49 6106-4073.

See us at the PITCON, Booth 1141 & 1143

CIRCLE 37 ON READER SERVICE CARD

One Of The Few Foam Problems We Can't Solve.

But we have antifoam agents for just about everything else.

Including products for both aqueous and non-aqueous systems. High and low pH. High temperatures. And food-related uses.

Our antifoam agents are concentrated, too. A little goes a long way, lasts a long time.

For samples or to talk to our antifoam experts...

Call 1-800 FOAM FREE

Or write: Dow Corning Corporation, Dept. A-7014, P.O. Box 7604, Mt. Prospect, IL 60056-7604.

DOW CORNING®

©1988 Dow Corning Corporation.

CIRCLE 17 ON READER SERVICE CARD

R&D declines as percent of future-oriented spending

After stabilizing over the previous two years, R&D expenditures as a percentage of future-oriented spending (capital expenditures plus R&D expenditures) have declined, according to figures supplied by the 12 major chemical producers C&EN contacted for its survey and by C&EN estimates.

In 1988, the R&D portion accounted for 35% of a total $11.2 billion in future-oriented spending, marking a 4% decrease in the R&D share of the total compared with 1987. In 1987 R&D accounted for 39% of a total $9.47 billion of future-oriented spending. The spread between 1988 and 1986 is an even higher 4.9%. In that year R&D spending accounted for nearly 40% of a total $8.85 billion in future-oriented spending.

The reason is that capital expenditures, fueled by increased commodity demands and higher prices, have increased at a faster pace than R&D. Eleven companies responding to C&EN's 1989 capital expenditure survey (C&EN, Dec. 19, 1988, page 10) reported capital expenditures in 1988 increased 31% from 1987. The rate of increase of R&D expenditures for 10 of the same eleven companies in 1988 was 7%.

Total 1987 = $9.47 billion

Total 1988 = $11.2 billion

Note: For companies listed on page 16. Source: C&EN surveys and estimates

Air Products researcher tests emulsion formulation for pressure-sensitive adhesives market

SmithKline Beckman report they had spent $650 million and $500 million, respectively, in 1988, marking 15% and 18% increases, respectively. The pharmaceutical manufacturers as a group consistently spend the highest percentage of sales on R&D. Of the three covered here, Eli Lilly spends the most—an estimated 12% of sales in 1988 and 13% in 1987.

The second largest increase for R&D spending among the diversified manufacturers in 1989 was registered by Arco Chemical, which plans to increase spending 19% to $44 million. The increase follows a 42% increase in R&D spending in 1988 to $37 million.

Morton Thiokol reports it plans a 16% increase in 1989 R&D spending to $52 million after a 13% increase in 1988 to $45 million. Only Allied-Signal says it has no plans to increase R&D spending levels in 1989 beyond what it actually spent in 1988. □